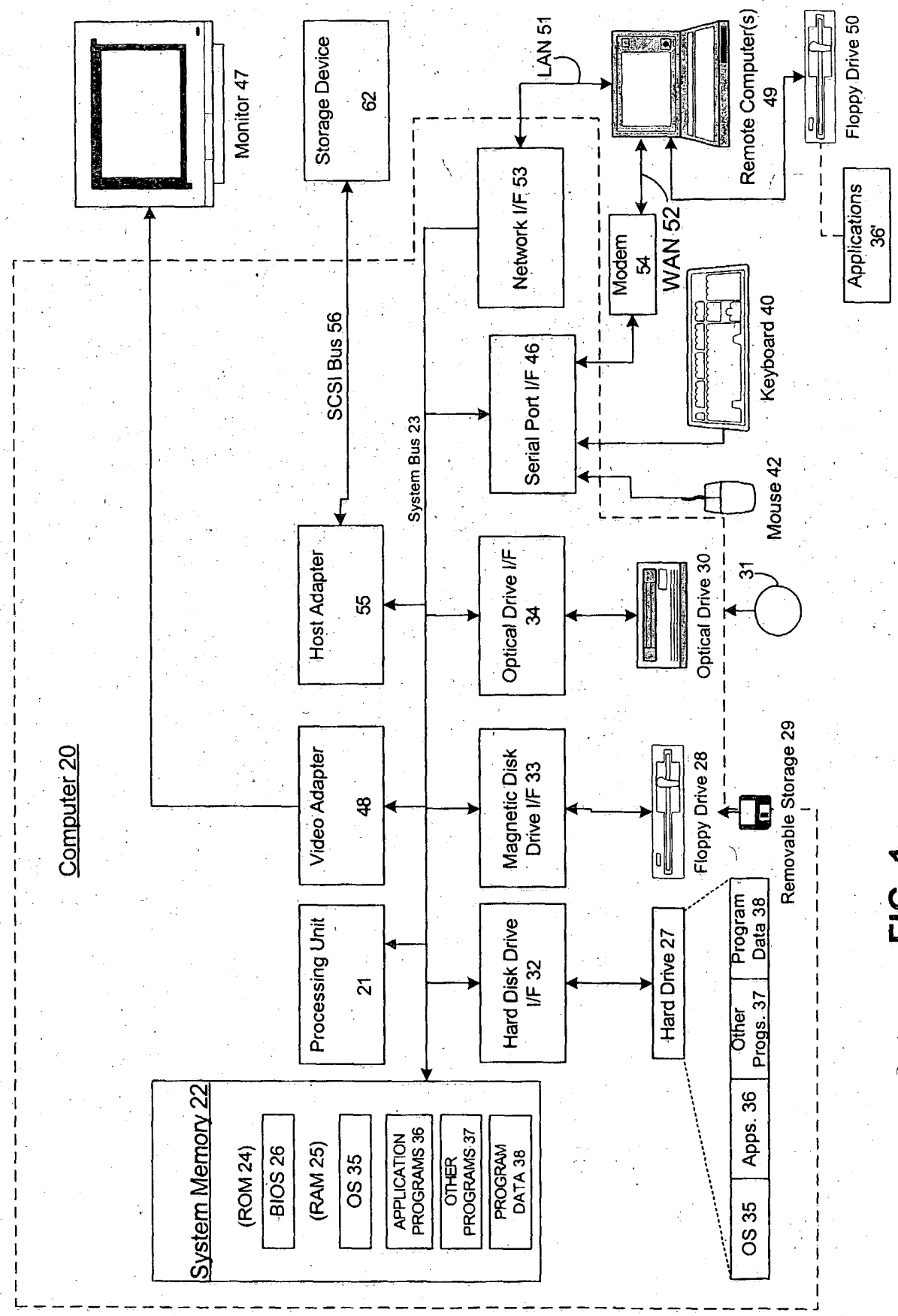

Computer 20
Monitor 47
Storage Device 62
LAN 51
Remote Computer(s) 49
Floppy Drive 50
Applications 36'
Network I/F 53
Modem 54
WAN 52
Keyboard 40
SCSI Bus 56
System Bus 23
Serial Port I/F 46
Mouse 42
Host Adapter 55
Optical Drive I/F 34
Optical Drive 30
31
Video Adapter 48
Magnetic Disk Drive I/F 33
Floppy Drive 28
Removable Storage 29
Processing Unit 21
Hard Disk Drive I/F 32
Hard Drive 27
Program Data 38
Other Progs. 37
Apps. 36
OS 35
System Memory 22
(ROM 24)
BIOS 26
(RAM 25)
OS 35
APPLICATION PROGRAMS 36
OTHER PROGRAMS 37
PROGRAM DATA 38

FIG. 1

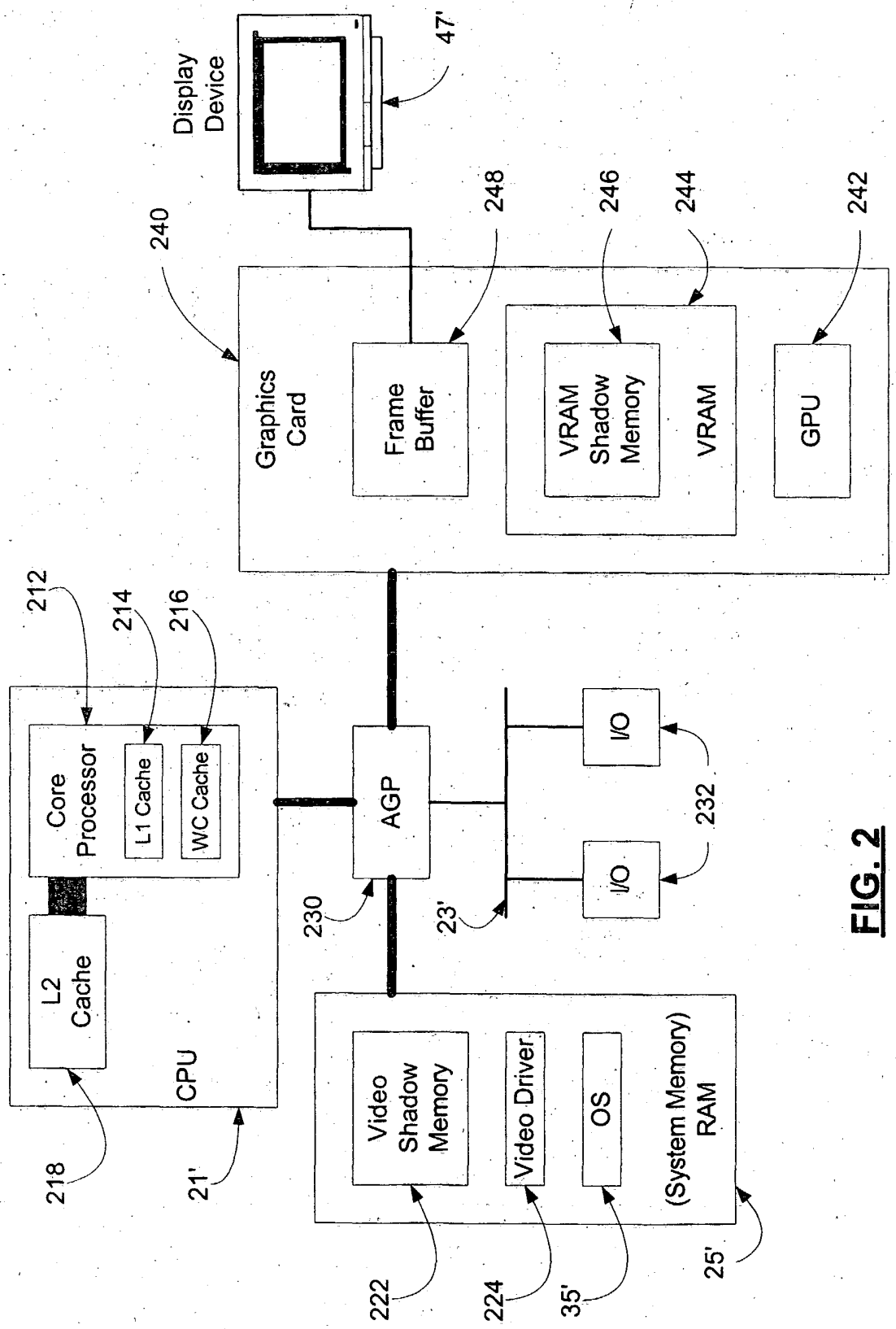

Display Device
47'
240
248
246
244
242
Graphics Card
Frame Buffer
VRAM Shadow Memory
VRAM
GPU
212
214
216
Core Processor
L1 Cache
WC Cache
L2 Cache
CPU
AGP
I/O
I/O
232
230
23'
218
21'
Video Shadow Memory
Video Driver
OS
(System Memory) RAM
222
224
35'
25'

FIG. 2

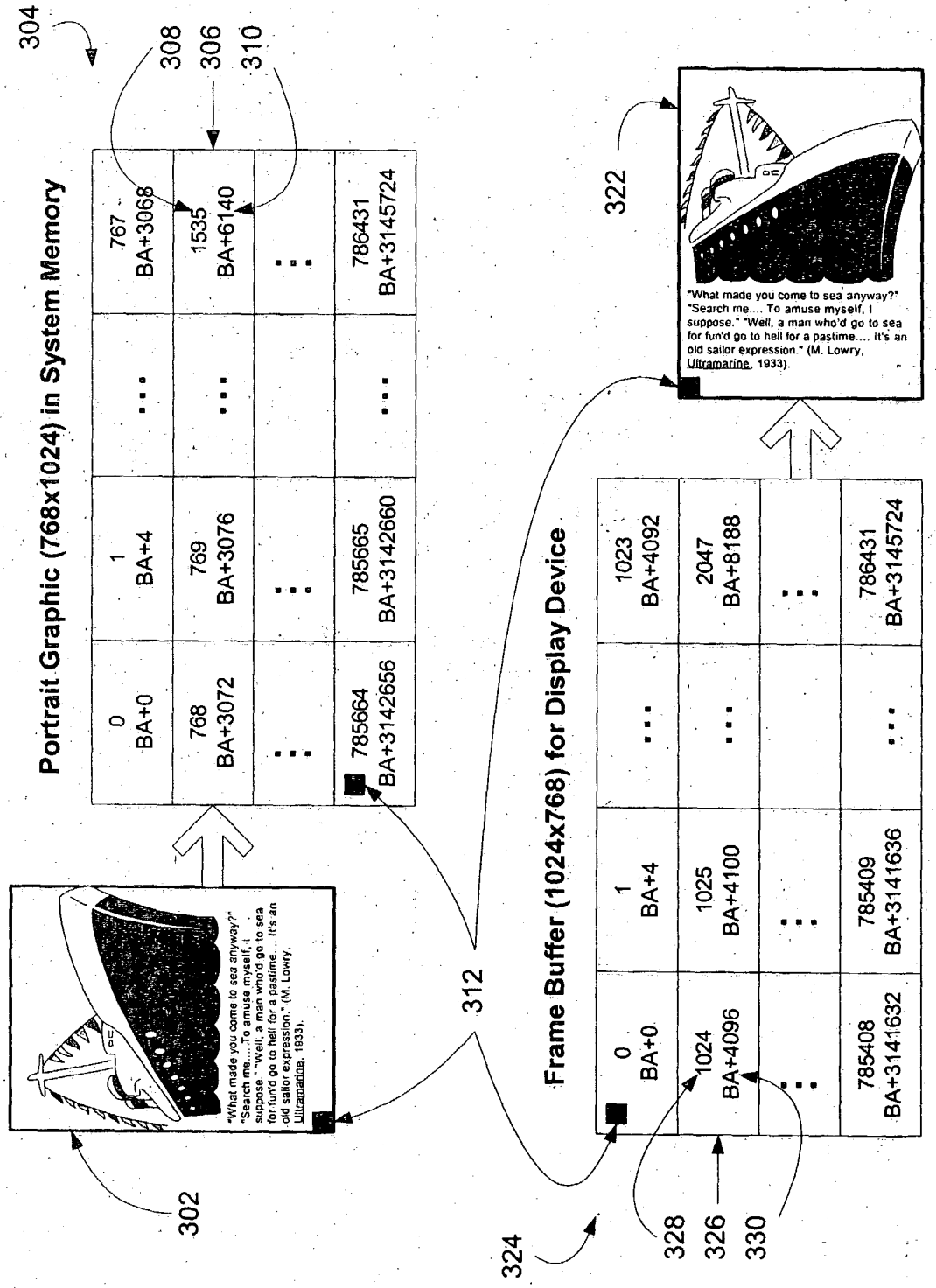

304
308
306
310
Portrait Graphic (768x1024) in System Memory
0 BA+0
1 BA+4
767 BA+3068
768 BA+3072
769 BA+3076
1535 BA+6140
785664 BA+3142656
785665 BA+3142660
786431 BA+3145724
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... it's an old sailor expression." (M. Lowry, Ultramarine, 1933).
322
312
Frame Buffer (1024x768) for Display Device
0 BA+0
1 BA+4
1023 BA+4092
1024 BA+4096
1025 BA+4100
2047 BA+8188
785408 BA+3141632
785409 BA+3141636
786431 BA+3145724
302
324
328
326
330

FIG. 3A

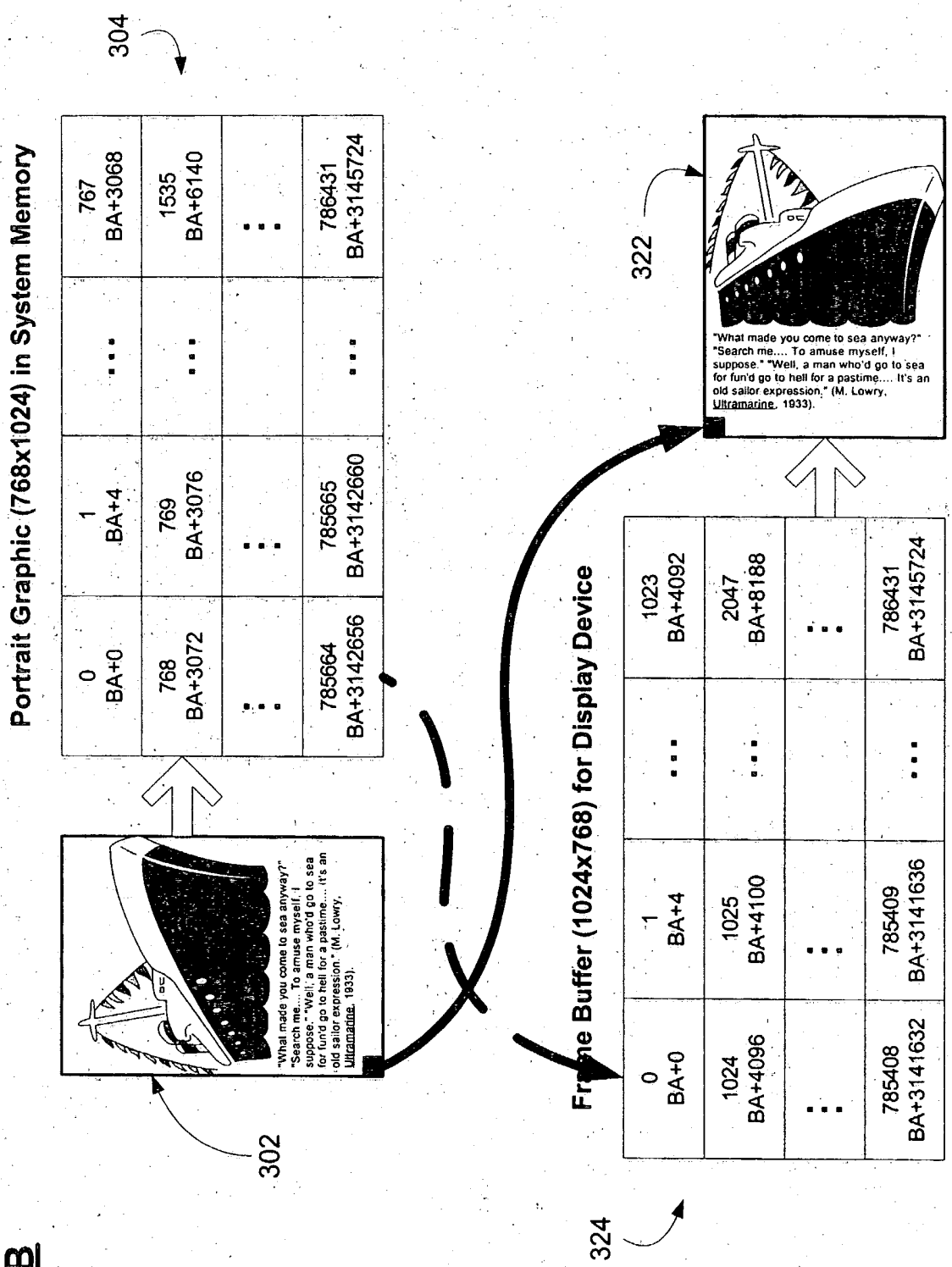

304
Portrait Graphic (768x1024) in System Memory
0 BA+0
1 BA+4
767 BA+3068
768 BA+3072
769 BA+3076
1535 BA+6140
785664 BA+3142656
785665 BA+3142660
786431 BA+3145724
302
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... it's an old sailor expression." (M. Lowry, Ultramarine, 1933).
322
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... It's an old sailor expression," (M. Lowry, Ultramarine, 1933).
Frame Buffer (1024x768) for Display Device
0 BA+0
1 BA+4
1023 BA+4092
1024 BA+4096
1025 BA+4100
2047 BA+8188
785408 BA+3141632
785409 BA+3141636
786431 BA+3145724
324

FIG. 3B

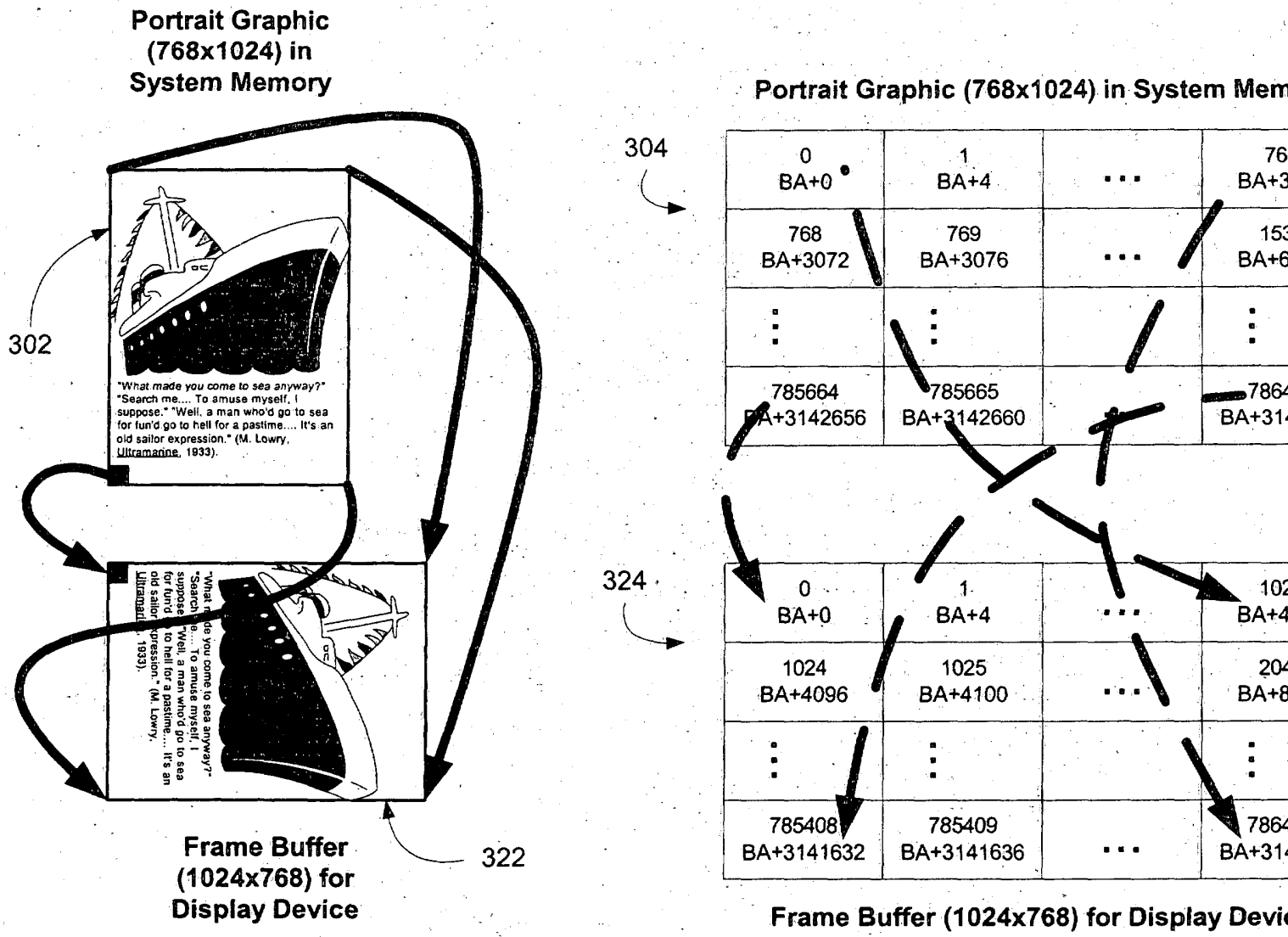

Portrait Graphic (768x1024) in System Memory
302
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... It's an old sailor expression." (M. Lowry, Ultramarine, 1933).
Frame Buffer (1024x768) for Display Device
322
Portrait Graphic (768x1024) in System Memory
304
0 BA+0
1 BA+4
767 BA+3068
768 BA+3072
769 BA+3076
1535 BA+6140
785664 BA+3142656
785665 BA+3142660
786431 BA+3145724
324
0 BA+0
1 BA+4
1023 BA+4092
1024 BA+4096
1025 BA+4100
2047 BA+8188
785408 BA+3141632
785409 BA+3141636
786431 BA+3145724
Frame Buffer (1024x768) for Display Device

FIG. 3C

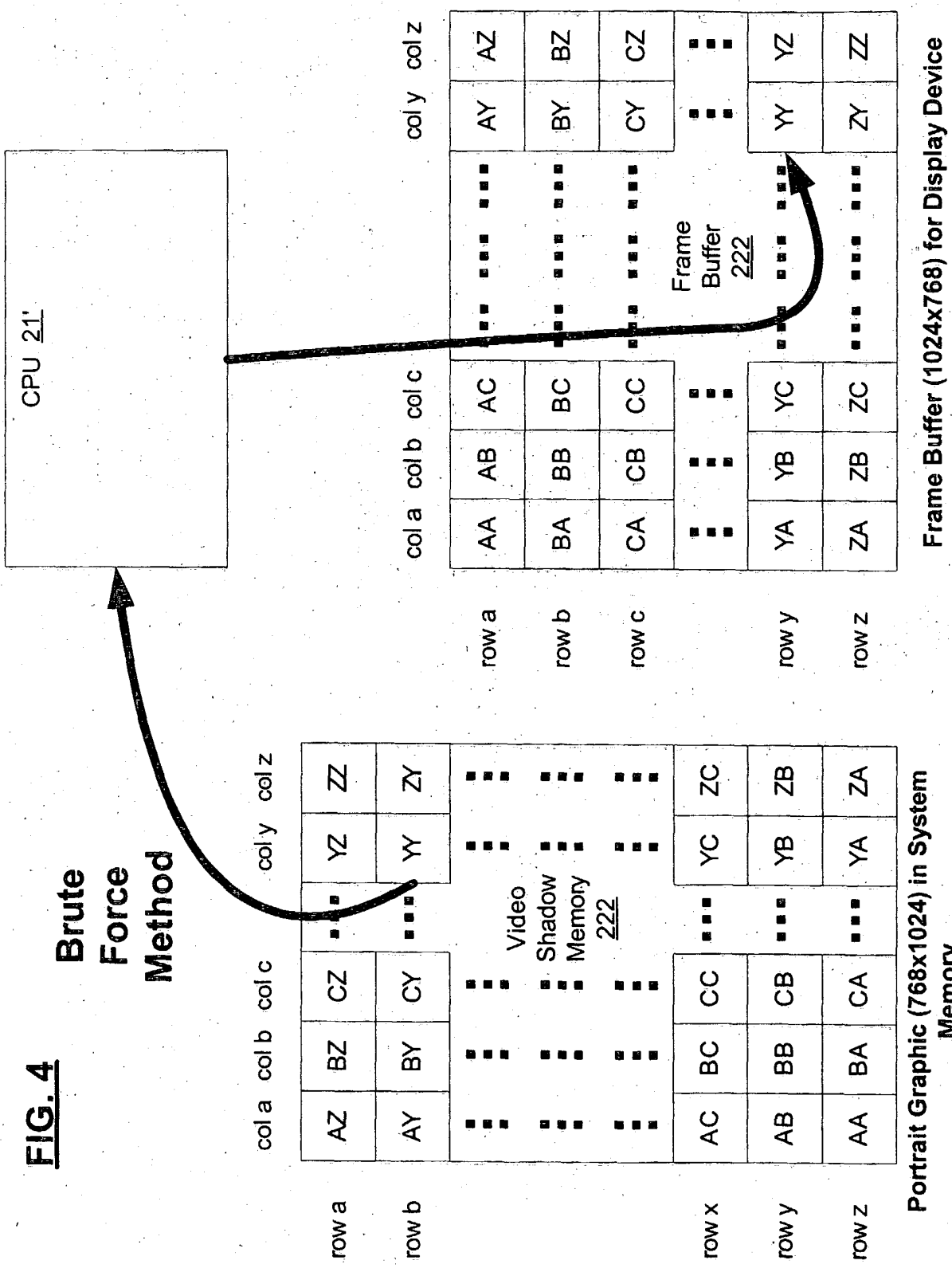
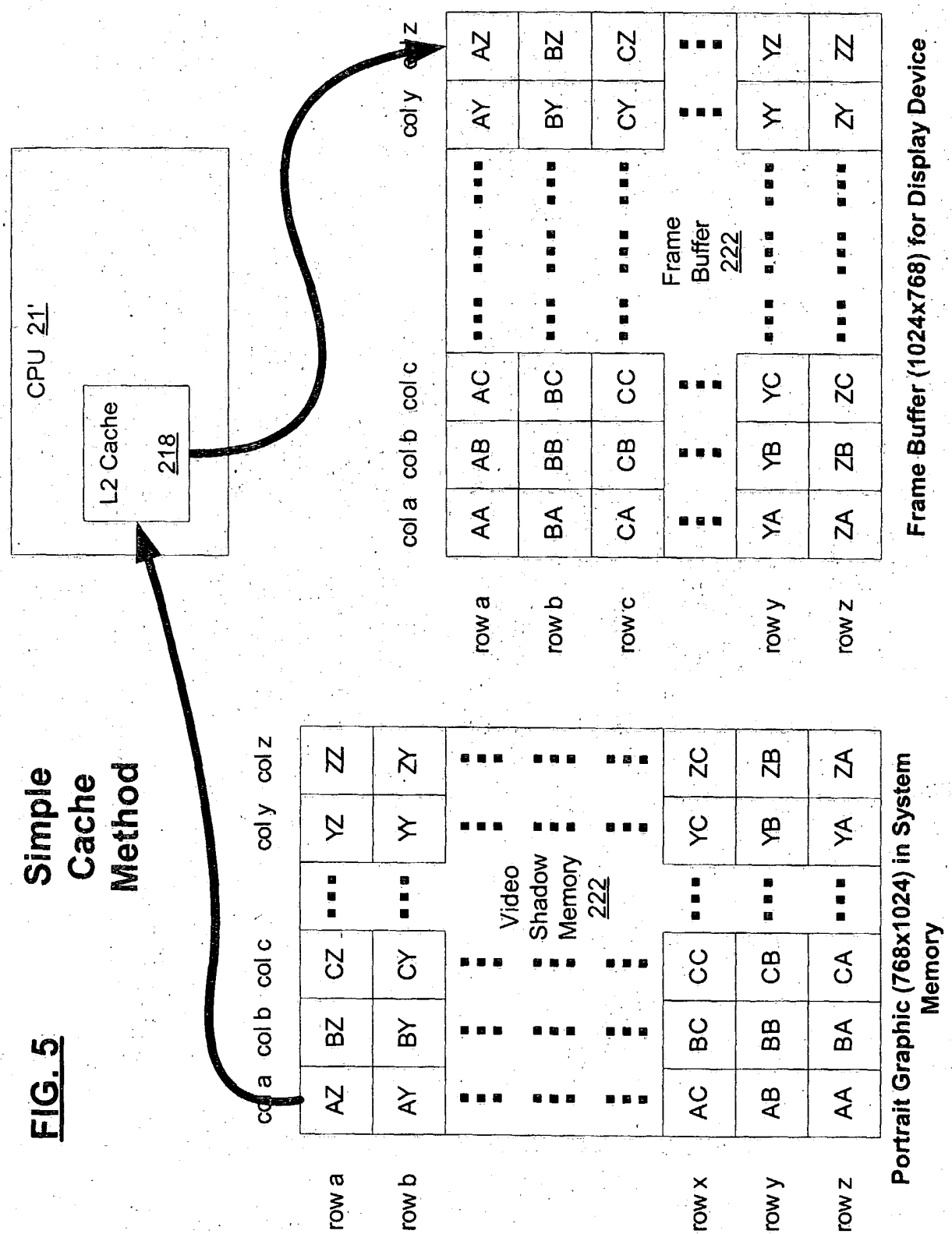

CPU 21'
Brute Force Method
col a col b col c col y col z
row a
row b
row x
row y
row z
AZ BZ CZ YZ ZZ
AY BY CY YY ZY
AC BC CC YC ZC
AB BB CB YB ZB
AA BA CA YA ZA
Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory
Frame Buffer 222
Frame Buffer (1024x768) for Display Device

FIG. 4

FIG. 5


Simple Cache Method
CPU 21'
L2 Cache 218
col a col b col c
col y col z
row a
row b
row c
row y
row z
AA AB AC
BA BB BC
CA CB CC
YA YB YC
ZA ZB ZC
AY AZ
BY BZ
CY CZ
YY YZ
ZY ZZ
Frame Buffer 222
Frame Buffer (1024x768) for Display Device
row a
row b
row x
row y
row z
AZ BZ CZ
AY BY CY
AC BC CC
AB BB CB
AA BA CA
YZ ZZ
YY ZY
YC ZC
YB ZB
YA ZA
Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory

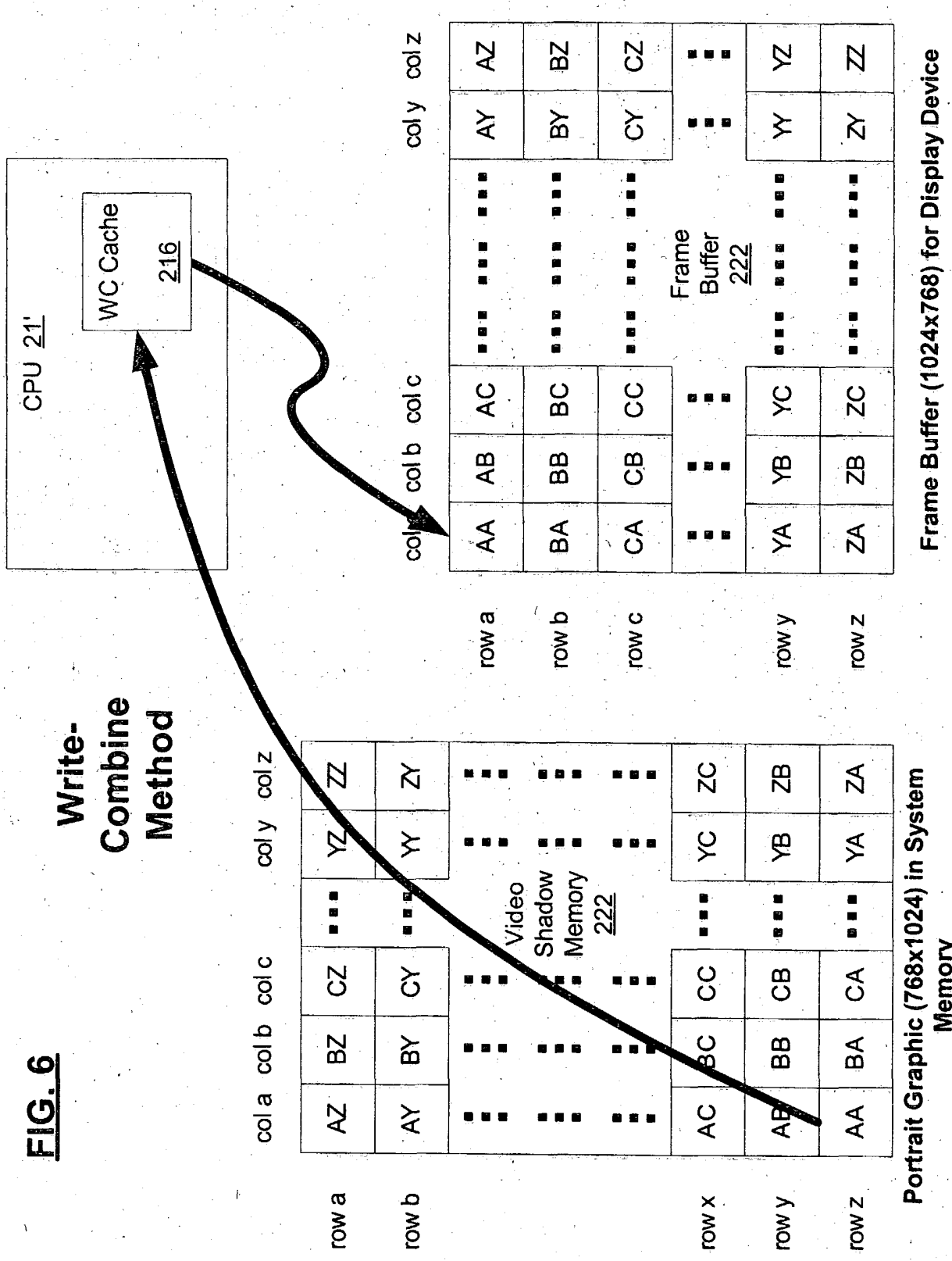

CPU 21'
WC Cache 216
Write-Combine Method
col a col b col c col y col z
row a
row b
row x
row y
row z
AZ BZ CZ YZ ZZ
AY BY CY YY ZY
AC BC CC YC ZC
AB BB CB YB ZB
AA BA CA YA ZA
Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory
col a col b col c col y col z
row a
row b
row c
row y
row z
AA AB AC AY AZ
BA BB BC BY BZ
CA CB CC CY CZ
YA YB YC YY YZ
ZA ZB ZC ZY ZZ
Frame Buffer 222
Frame Buffer (1024x768) for Display Device

FIG. 6

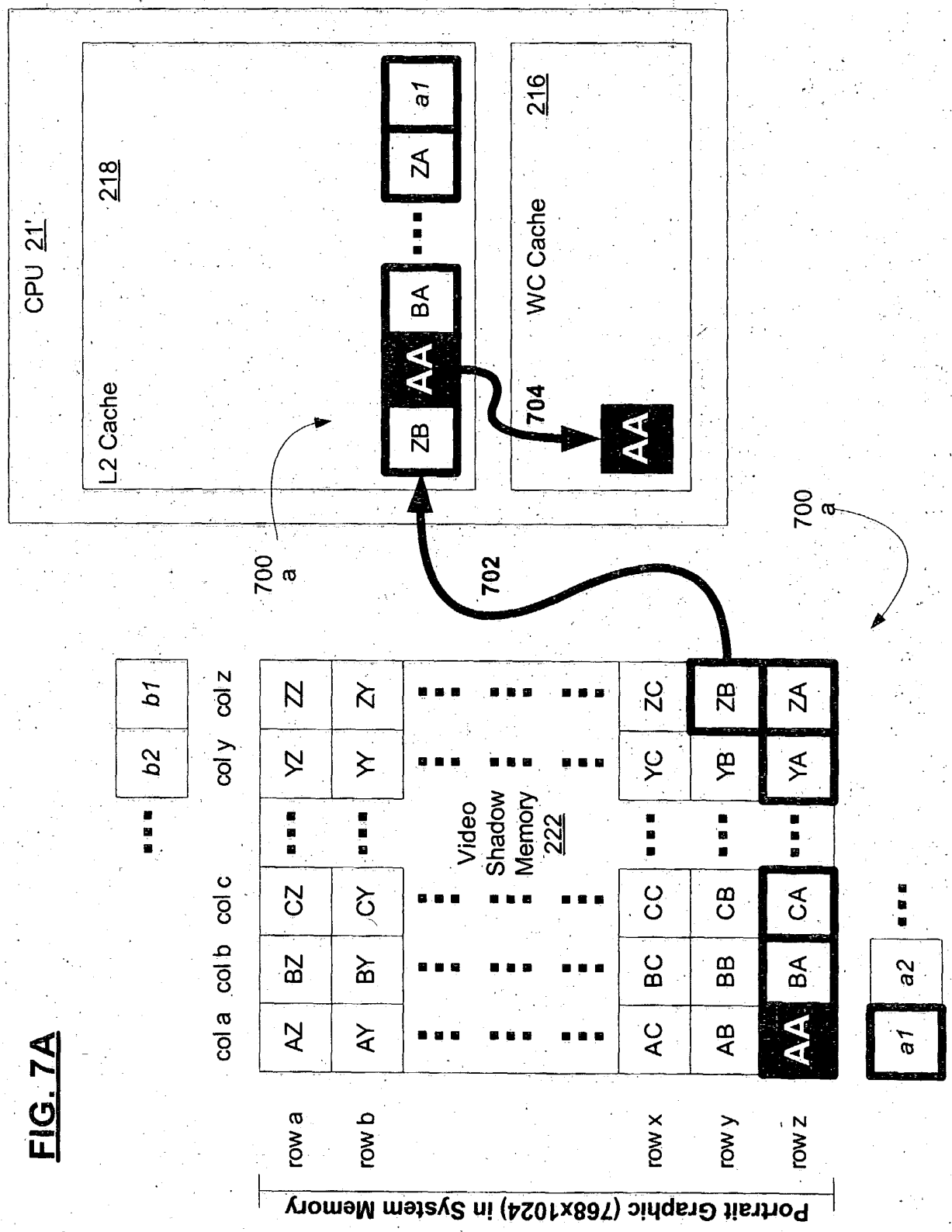

CPU 21'
L2 Cache
218
ZB
AA
BA
ZA
a1
WC Cache
216
704
AA
700
a
702
700
a
Video Shadow Memory 222
col a
col b
col c
col y
col z
row a
row b
row x
row y
row z
AZ
BZ
CZ
AY
BY
CY
AC
BC
CC
AB
BB
CB
AA
BA
CA
ZZ
YZ
ZY
YY
ZC
YC
ZB
YB
ZA
YA
b1
b2
a1
a2
Portrait Graphic (768x1024) in System Memory

FIG. 7A

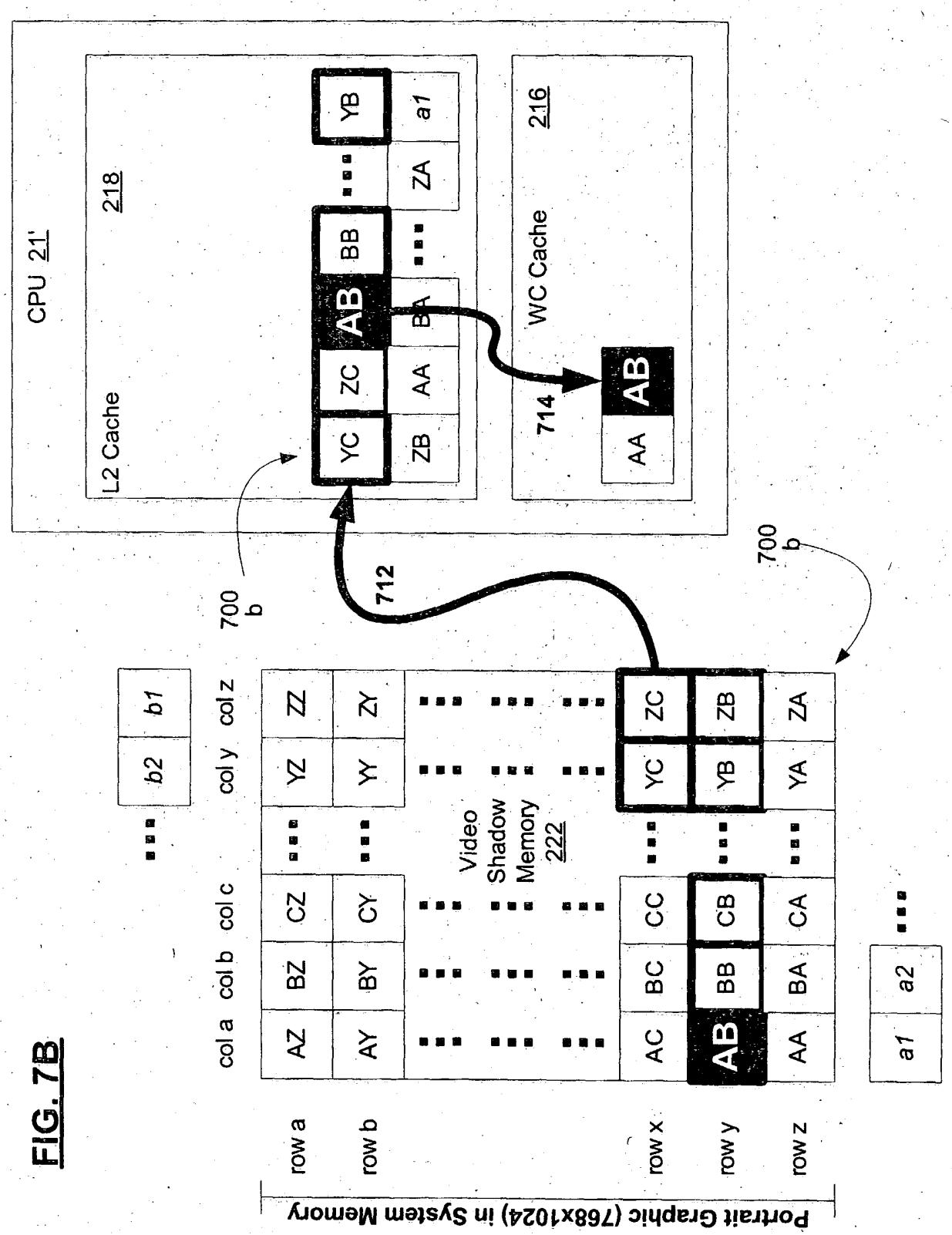

CPU 21'
L2 Cache
218
YC
ZC
AB
BB
ZB
AA
BA
YB
ZA
a1
WC Cache
216
714
AB
AA
712
700
b
700
b
Video Shadow Memory 222
col a
col b
col c
col y
col z
row a
row b
row x
row y
row z
Portrait Graphic (768x1024) in System Memory
b1
b2
a1
a2

FIG. 7B

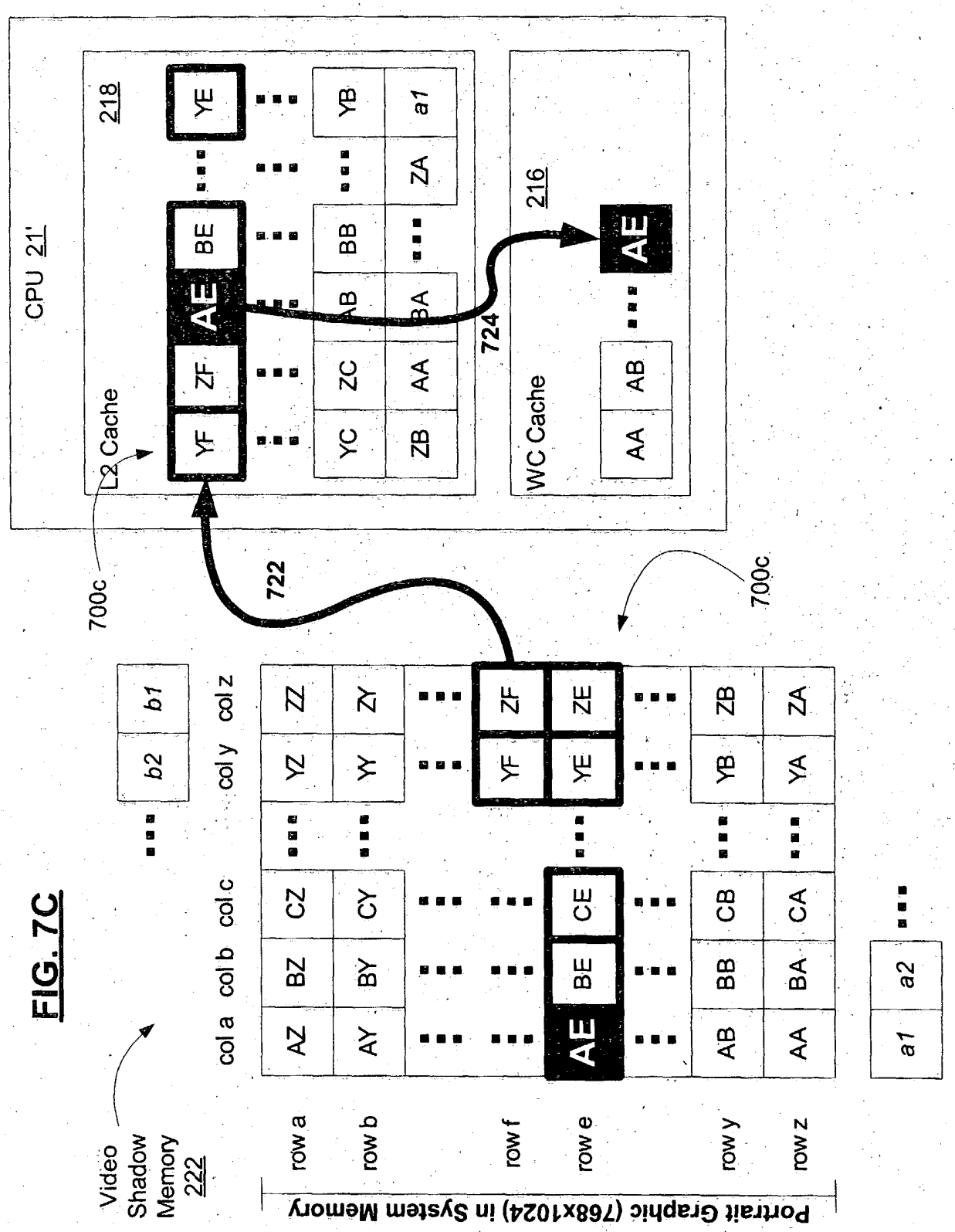

CPU 21'
218
L2 Cache
YF ZF AE BE YE
YC ZC AB BB YB
ZB AA BA ZA a1
216
WC Cache
AA AB AE
724
700c
722
700c
col a col b col c col y col z
AZ BZ CZ YZ ZZ
AY BY CY YY ZY
AE BE CE YF ZF ZE
AB BB CB YB ZB
AA BA CA YA ZA
a1 a2
b2 b1
row a
row b
row f
row e
row y
row z
Portrait Graphic (768x1024) in System Memory
Video Shadow Memory 222

FIG. 7C

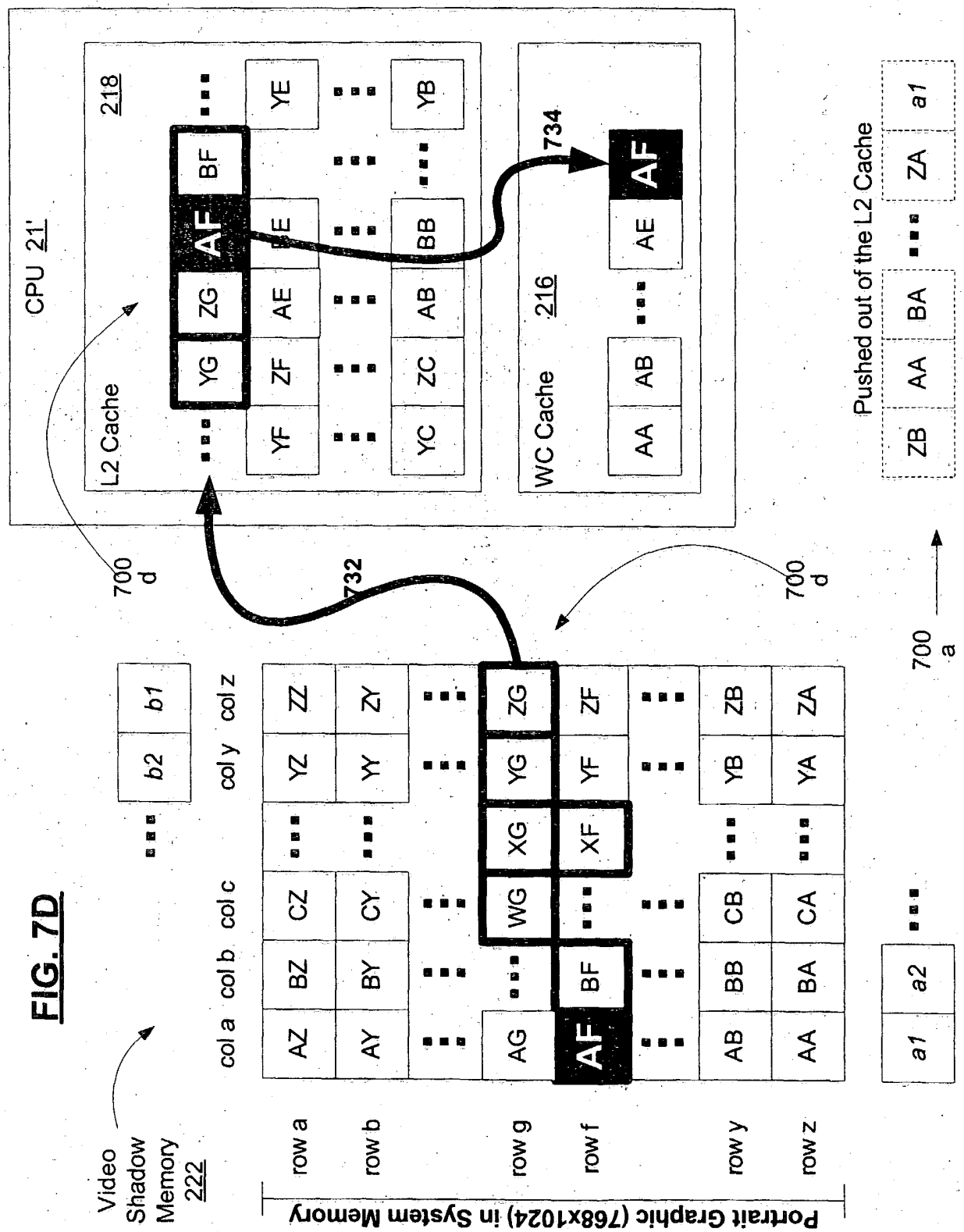

CPU 21'
218
L2 Cache
WC Cache 216
734
732
700 d
700 d
700 a
Pushed out of the L2 Cache
Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory
row a
row b
row g
row f
row y
row z
col a
col b
col c
col y
col z

FIG. 7D

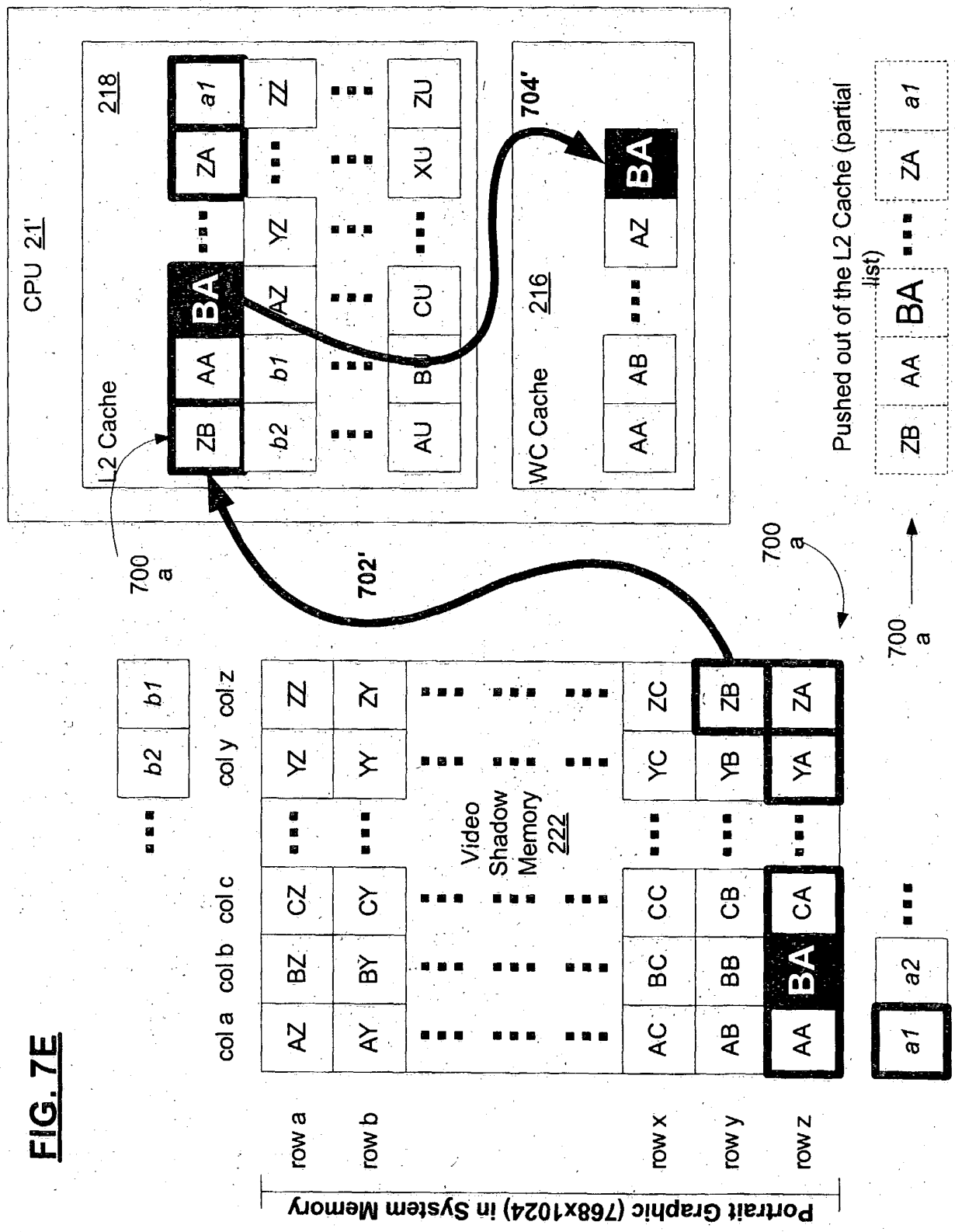

CPU 21'
218
L2 Cache
WC Cache 216
704'
702'
700 a
Pushed out of the L2 Cache (partial list)
Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory
row a
row b
row x
row y
row z
col a
col b
col c
col y
col z

FIG. 7E

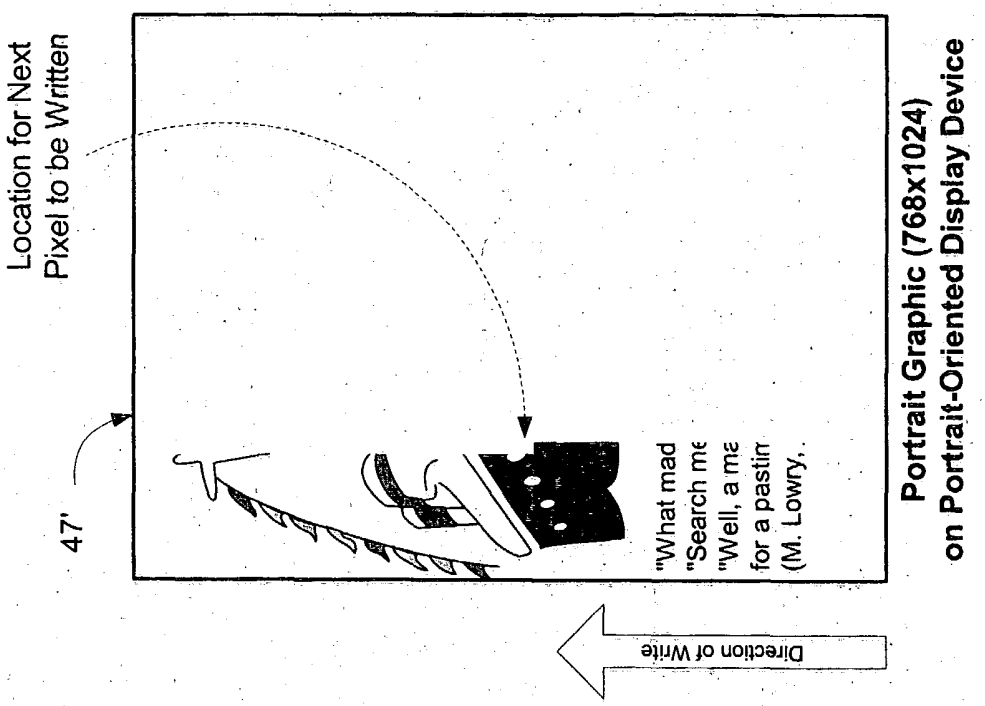

Location for Next Pixel to be Written
47'
Direction of Write
Portrait Graphic (768x1024) on Portrait-Oriented Display Device

FIG. 8B

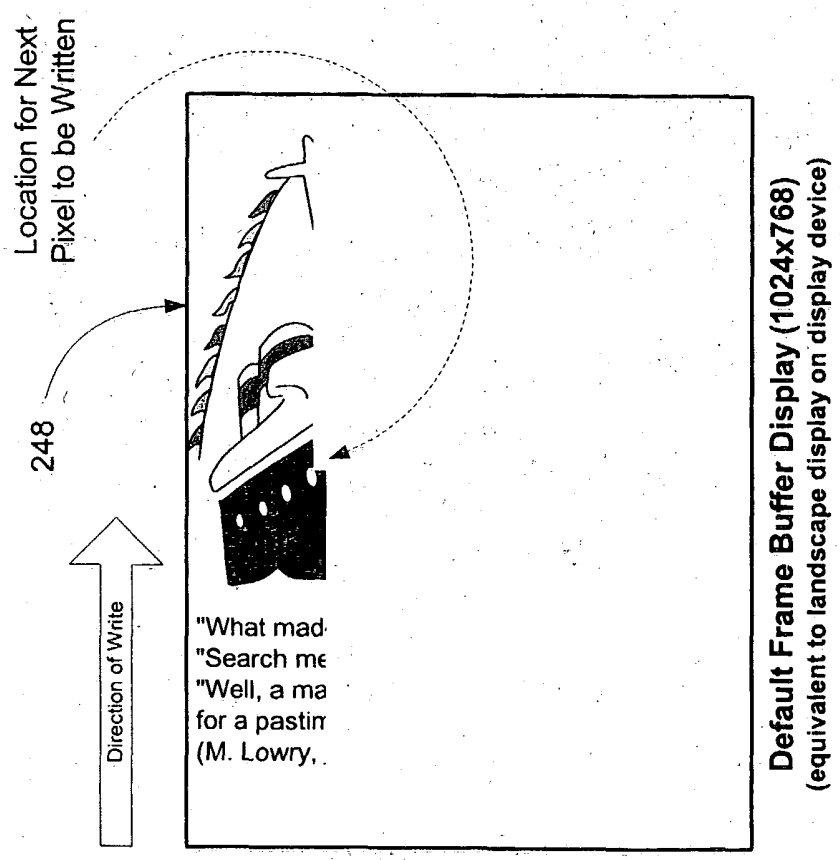
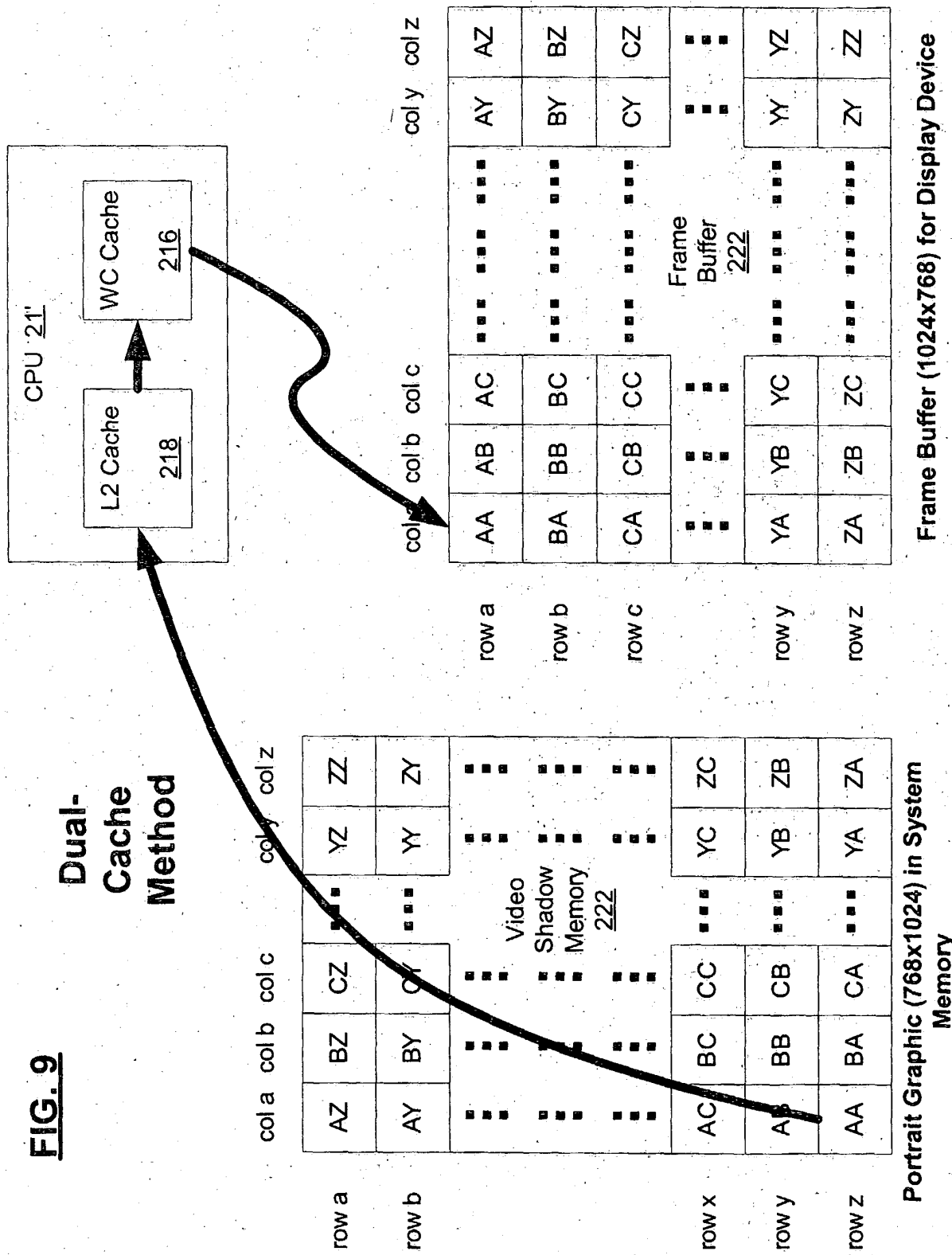

Location for Next Pixel to be Written
248
Direction of Write
Default Frame Buffer Display (1024x768)
(equivalent to landscape display on display device)

FIG. 8A

Next Pixel
Start
Write-Combine Method:
Rasterized Draw Pattern
Portrait Graphic (768x1024) on Portrait-Oriented Display Device

FIG. 8C

FIG. 9


Dual-Cache Method
CPU 21'
L2 Cache 218
WC Cache 216
col a col b col c col y col z
row a
row b
row x
row y
row z
AZ BZ CZ YZ ZZ
AY BY CY YY ZY
AC BC CC YC ZC
AB BB CB YB ZB
AA BA CA YA ZA
Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory
col a col b col c col y col z
row a
row b
row c
row y
row z
AA AB AC AY AZ
BA BB BC BY BZ
CA CB CC CY CZ
YA YB YC YY YZ
ZA ZB ZC ZY ZZ
Frame Buffer 222
Frame Buffer (1024x768) for Display Device

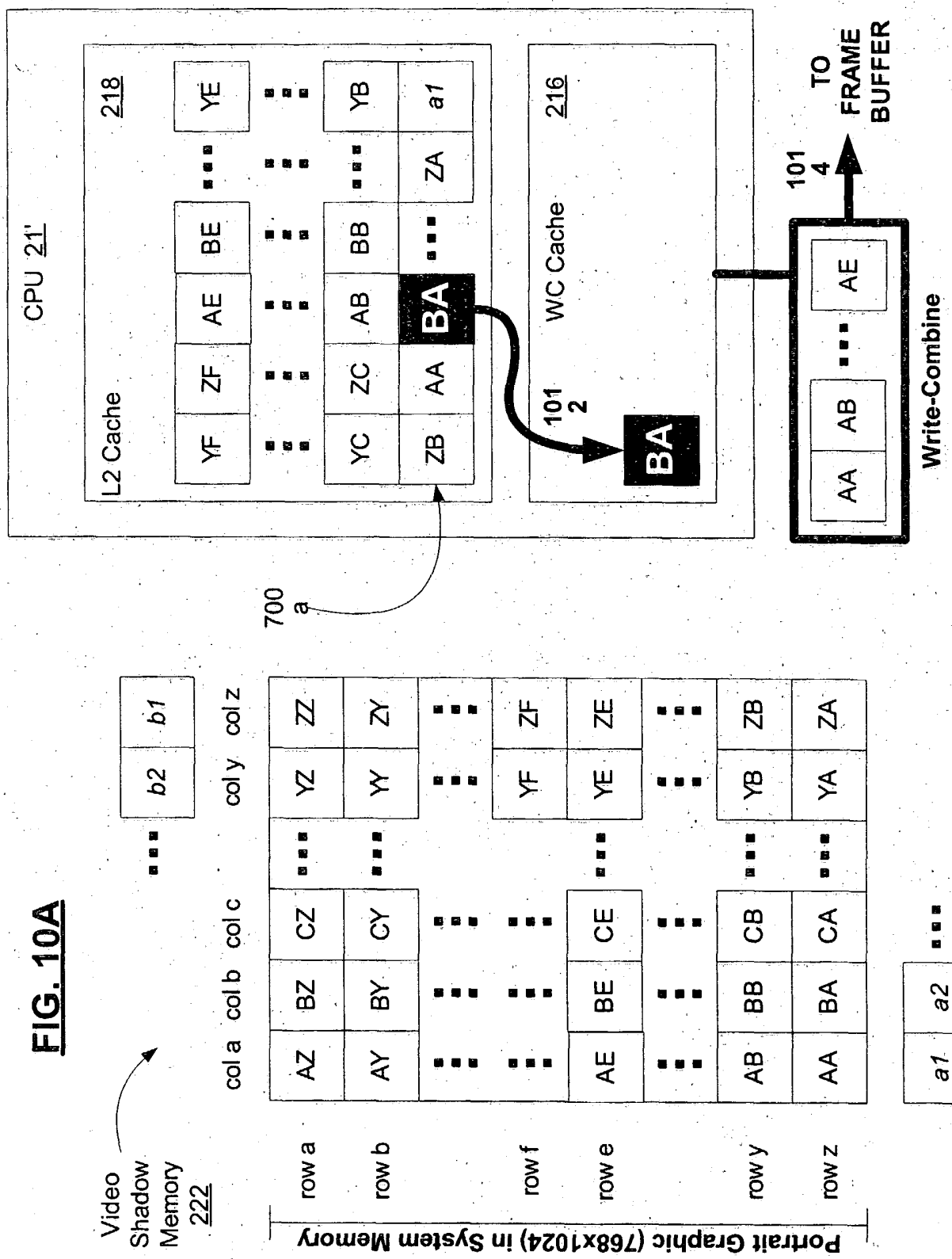
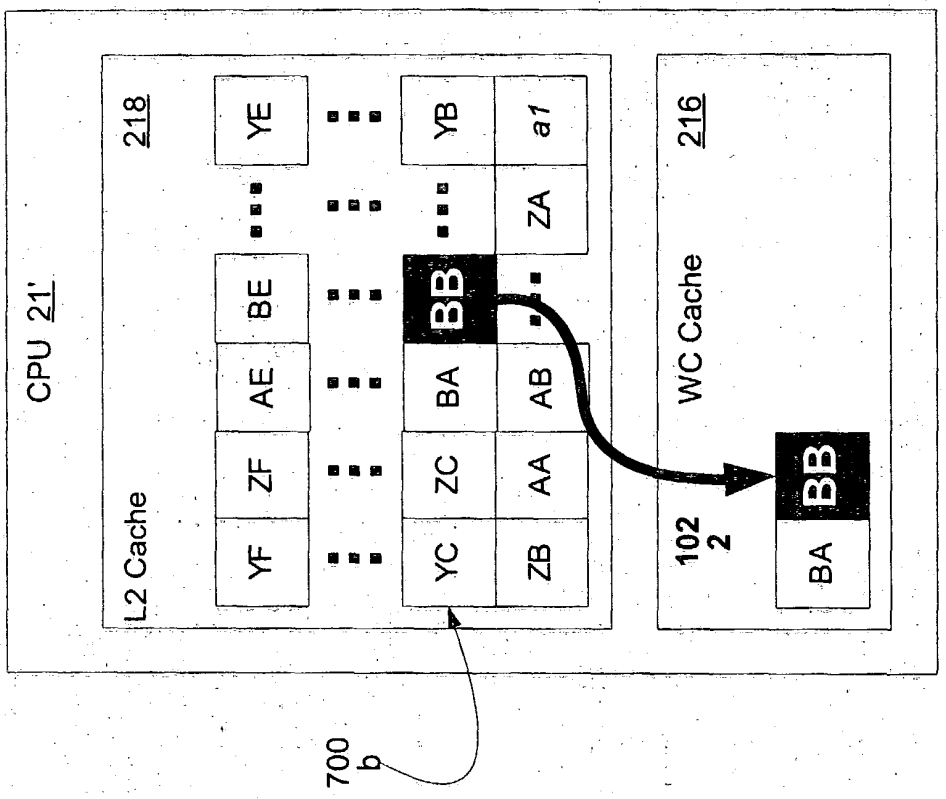

CPU 21'
218
L2 Cache
YF ZF AE BE YE
YC ZC AB BA BB YB
ZB AA a1 ZA
216
WC Cache
101
2
BA
101
4
TO FRAME BUFFER
AA AB AE
Write-Combine
700
a
Video Shadow Memory 222
col a col b col c col y col z
AZ BZ CZ YZ ZZ
AY BY CY YY ZY
AE BE CE YE ZE
AB BB CB YB ZB
AA BA CA YA ZA
a1 a2
b2 b1
row a row b row f row e row y row z
Portrait Graphic (768x1024) in System Memory

FIG. 10A


CPU 21'
L2 Cache
218
YF
ZF
AE
BE
YC
ZC
BA
BB
ZB
AA
AB
YE
YB
a1
ZA
WC Cache
216
102
2
BA
BB
700
b

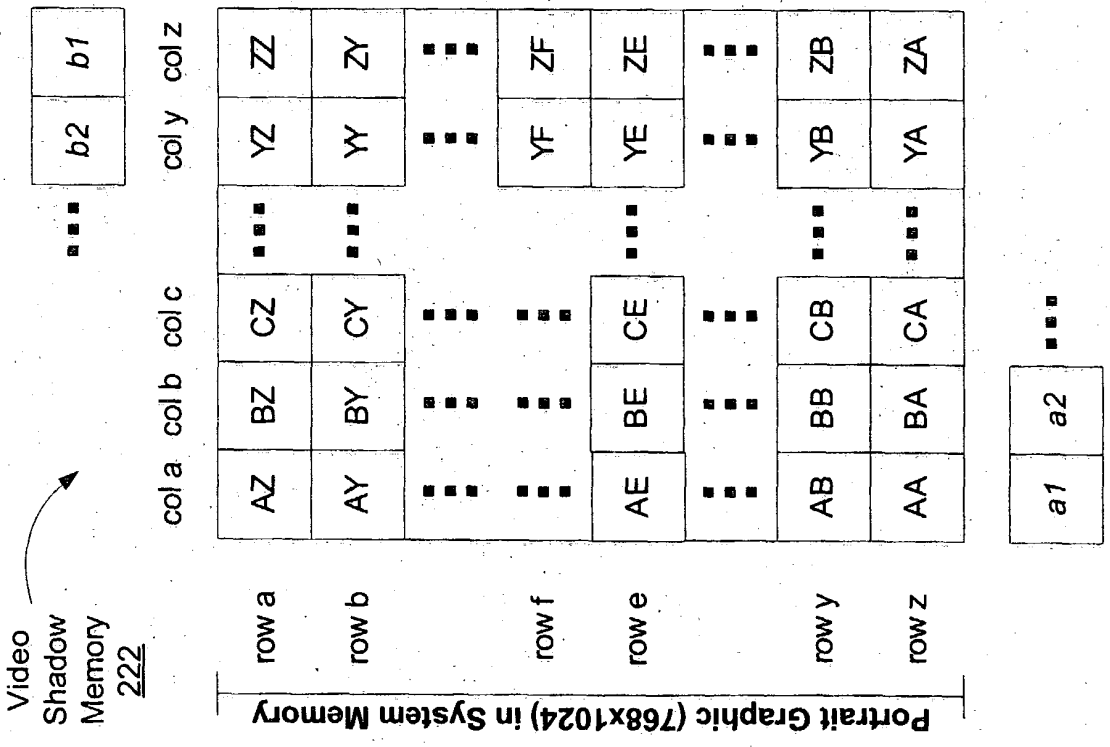

Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory
row a
row b
row f
row e
row y
row z
col a
col b
col c
col y
col z
AZ
BZ
CZ
YZ
ZZ
AY
BY
CY
YY
ZY
AE
BE
CE
YF
ZF
YE
ZE
AB
BB
CB
YB
ZB
AA
BA
CA
YA
ZA
a1
a2
b2
b1

FIG. 10B

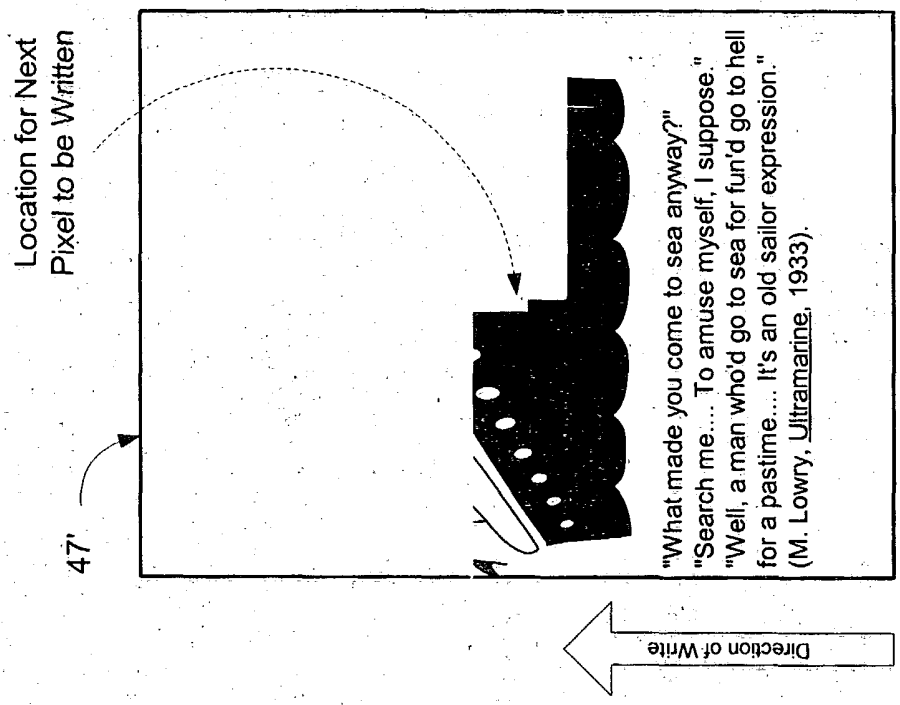


FIG. 11B

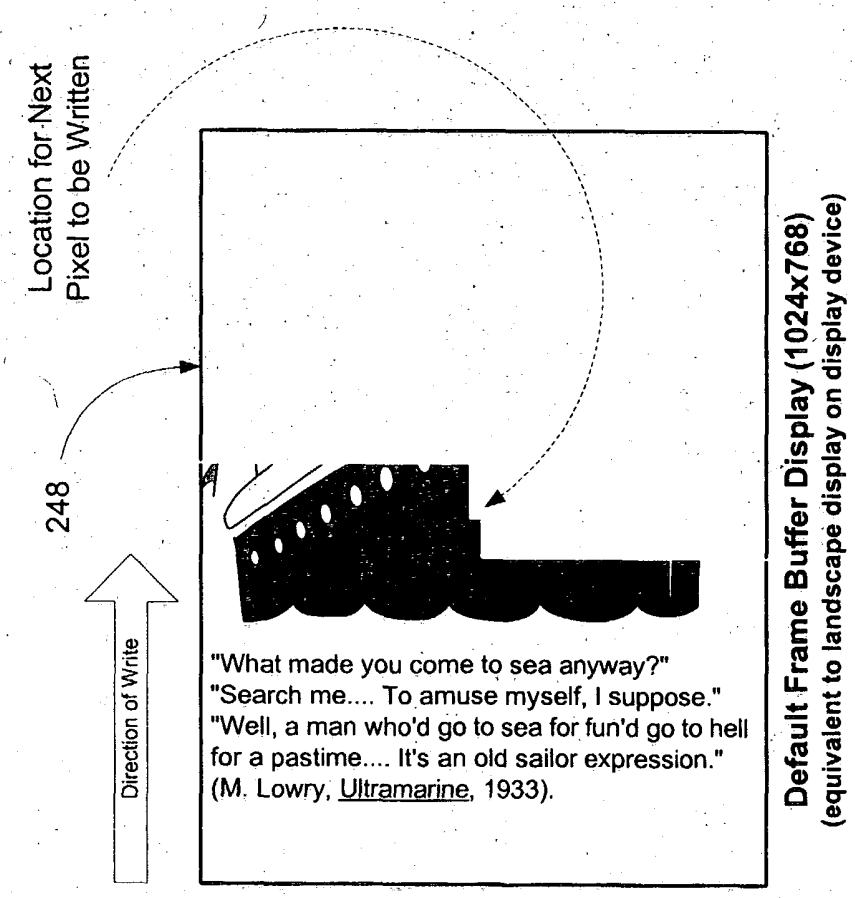
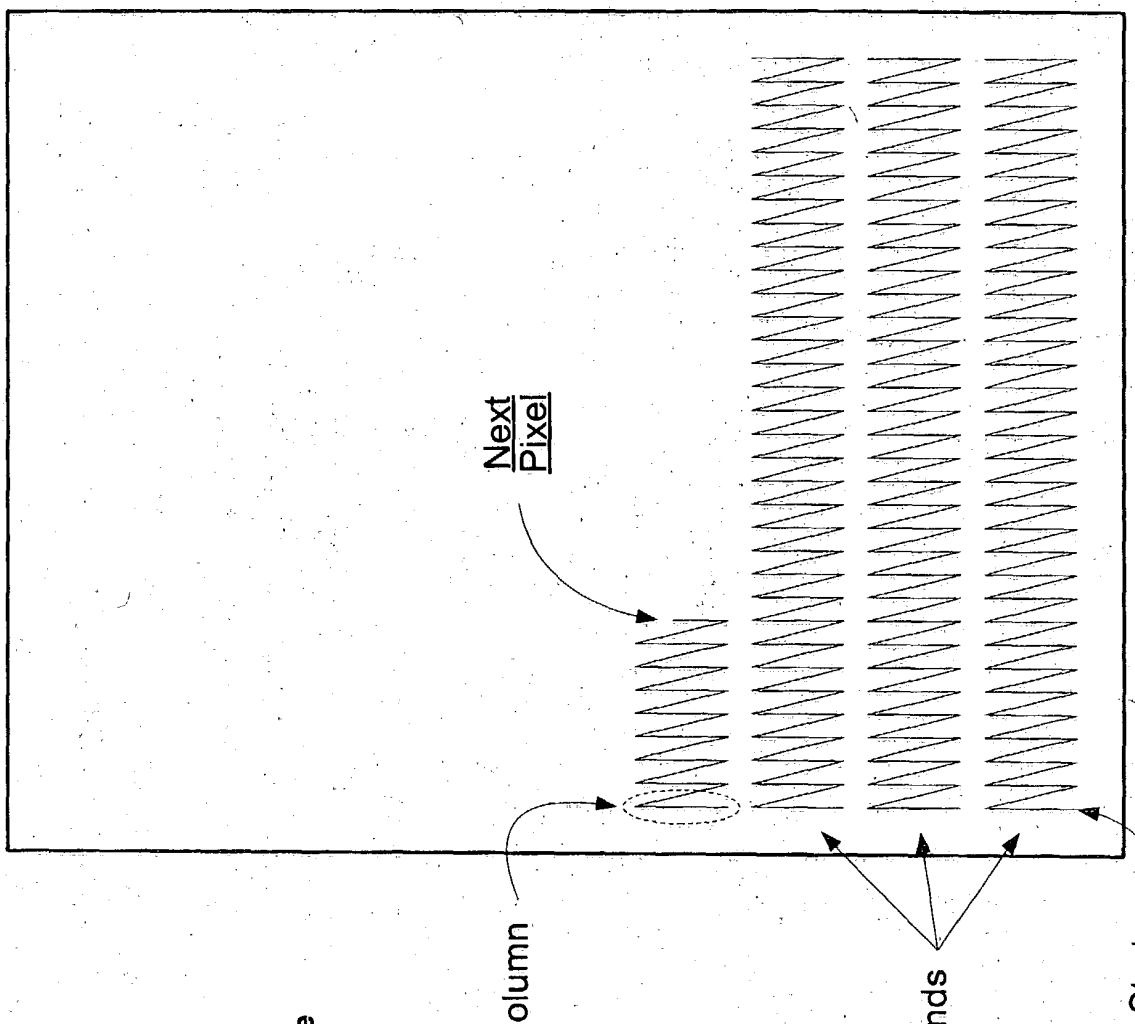


FIG. 11A



Dual-Cache Method:

Rasterized Draw Pattern

Portrait Graphic (768x1024) on Portrait-Oriented Display Device

FIG. 11C

FIG. 12

ANALYSIS OF PRESENT INVENTION VERSUS EXISTING METHODS IN THE ART

General Analysis:

	RAM Reads	FB Writes	Total "Slow" Operations
Brute Force (or GPU):	786,432	786,432	2,359,296
CPU w/ L2 Cache:	768	786,432	1,573,632
Write Combine Only (approx):	786,432	768	787,968
Write-Combine & L2 Cache Optimization (approx):	768	24,576	49,920

RAM Reads = 1 slow operation
FB Writes = 2 slow operations

Assumptions for Analysis:

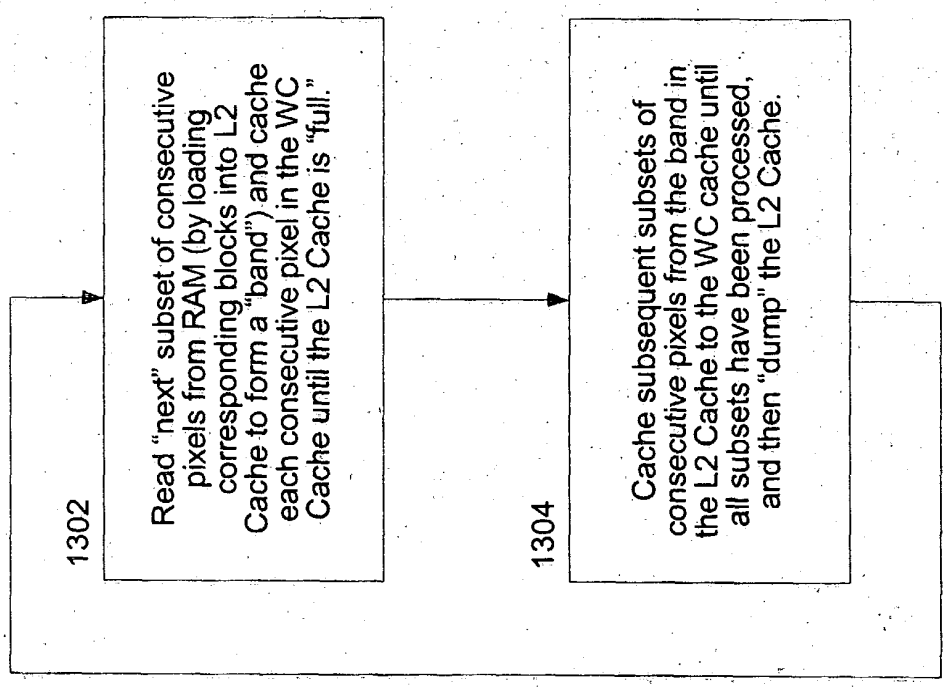
	KB:	Bytes:
Write Combine Buffer:	4	4,096
Each Pixel:	0.0039	4
L2 Cache for Images:	128	131,072

Total Pixels (1024x768):	786,432

*This is the amount of total L2 cache memory 'dedicated' to holding RAM Read info...

Docket No.: MSFT-1787 App. No.: Not yet assigned Filed: Herewith
Title: SYSTEMS AND METHODS FOR EFFICIENTLY DISPLAYING GRAPHICS ON A DISPLAY DEVICE REGARDLESS OF PHYSICAL ORIENTATION
Inventor: Donald D. Karlov
Attorney: Richard W. Knight Phone: (215) 568-3100
Sheet 21 of 22

FIG. 13


1302
Read "next" subset of consecutive pixels from RAM (by loading corresponding blocks into L2 Cache to form a "band") and cache each consecutive pixel in the WC Cache until the L2 Cache is "full."
1304
Cache subsequent subsets of consecutive pixels from the band in the L2 Cache to the WC cache until all subsets have been processed, and then "dump" the L2 Cache.